REMARKS

The applicants have carefully studied the outstanding final Office Action. The applicants gratefully acknowledge the Examiner's indication that claim 179 is allowable, and that claims 127, 135, 150, 151, 163-165, 177 (thus understood by the applicants, though stated by the Examiner to be claim 117) and 178 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The applicants have made a number of minor amendments to the claims currently on file, generally to correct inadvertent errors discovered in the relevant claims, and believe that the present amendment is fully responsive to all points of rejection raised by the Examiner, and is believed to place the application in condition for allowance. Entry of this response and favorable reconsideration and allowance of the application are respectfully requested.

Claim amendments

Claim 122 has been amended such that the last phrase thereof now recites "at least one of said first and second isotopic components", since each filter used defines wavelengths characteristic of at least one component.

Claim 133 has been amended by deletion of the phrase "viewing outputs of said two wavelength-stable sources in the presence of gas to be analyzed" used to limit the detector, as it has no antecedent basis as such.

Claim 134 has been amended by deletion of the phrase "viewing outputs of said two wavelength-stable sources in the presence of gas to be analyzed" used to limit the detector, as it has no antecedent basis as such. In addition, the recitation "first and second gas discharge lamps", has been replaced by "at least

two wavelength-stable sources of radiation" to comply with the recitation of claims 116 and 130, on which it is dependent.

Claim 135 has been made dependent on claim 130 instead of on claim 134, and the limitation from claim 134, that "said at least one detector comprises two detectors", has been added. Dependency on claim 134 was made erroneously, since claim 134 is intended to cover the embodiments of Figs. 11, 14 and 15, in which one detector views the first sample and reference chambers, and the other detector views the second sample and reference chambers, and claim 135 is intended to cover the embodiments of Figs. 1A and 1B, in which one detector views the first sample and reference chambers, and the second sample and reference chambers, and the other detector views the zero calibration signals.

Claim 163 has been amended by the replacement of the recitation "zero reference channel" with "zero calibration channel", in order to comply with the nomenclature generally used in the specification and in the other claims, such as claim 135. Furthermore, the zero calibration channel has been added as an additional element to the claim, to provide correct antecedent basis for its recitation in the limiting element of the claim.

Claim 168 has been amended by the replacement of the recitation "zero reference channel" with "zero calibration channel", for the reasons delineated in relation to claim 163.

Claim 190 has been amended, in the same manner as claim 122, such that the last phrase thereof now recites "at least one of said first and second isotopic components", since each filter used will generally define wavelengths characteristic of at least one component.

Claim 191 is a new dependent claim, being the equivalent of claim 130, but dependent on claim 117, instead of on claim 116 on which claim 130 is dependent.

Claim 192 is a new dependent claim, being the equivalent of claim 135, but dependent on claim 191 instead of on claim 130.

The applicants respectfully submit that the claim amendments have been necessitated by erroneous recitations in the respective claims on file, and do not add any new material. Additionally, new claims 191 and 192 are dependent claims equivalent to existing claims with parallel dependencies, and also do not add any new material. Entry and consideration of these claims is therefore earnestly requested.

Claim rejections - 35 USC § 103(a)

Claims 112-126, 128, 129, 130-134, 136-149, 151, 158-161, 166-176 and 180-190 stand rejected under 35 U.S.C 103(a) as being unpatentable over Eckstrom in view of Sauke et al. The Examiner states that "Eckstrom has a device for measuring a $^{13}CO_2/^{12}CO_2$ ratio, including first and second sample chambers that are thermally and pneumatically connected and first and second reference chambers that are thermally and pneumatically connected, and one (Fig. 1) or two (Fig. 3) *light sources* (omitted by the Examiner but thus understood) including a chopper or electronic modulation means, and filters 44 and 46 for resolving the light source into the proper spectral ranges. The reference gas of Eckstrom does not contain the isotopes to be measured. Sauke et al., shows a similar system where the reference gas does have the isotopes. The Examiner asserts that it would hence have been obvious to modify Eckstrom to use the reference gas of Sauke, as it is merely substitution of one known reference gas for another."

The applicants respectfully submit that the use of the reference gas of Sauke et al., is not "merely substitution of one known reference gas for another", as claimed by the Examiner, but that the use of a reference gas containing the isotopes to be measured, rather than one free of the analyte molecule, results in a fundamental and non-obvious innovative change to the system described in Eckstrom, and to its ability to accurately measure an isotopic ratio, as the applicants will now explain.

One of the major problems in the use of NDIR spectrometry for isotopic analysis, which is addressed with a greater or lesser degree of success by the Eckstrom, Sauke and the currently claimed inventions, is the need for reproducibility and stability in the optical absorption measurements, such that accurate measurements can be made of the minute changes in absorption arising from the different isotopic species present in the gas being analyzed. This optical absorption arises not from a single discrete absorption line, but from a range of multiple lines which cover the complete spectrum of interest of the characteristic molecule with the isotopic species. This means that the reproducibility and stability in the optical absorption measurements has to be maintained with respect to the entire spectral content of the measured radiation, and not just to an intensity at one discrete wavelength. This is true even for a narrow bandwidth measurement, which would still cover a specific number of discrete lines of the total spectrum of the characteristic absorption of the analyte molecules.

Lack of reproducibility and stability in the optical absorption measurements can arise both from operating conditions of the analyzing instrument components, and from the environmental conditions during measurement. Examples of the former include aging of the detector or detectors which affects their relative spectral sensitivity, aging of the wavelength-stable source or sources of radiation which can result in change in their comparative spectral composition, certainly for a filtered black body source, and even for an isotope-characteristic gas discharge source; changes in the spectral transmission of chamber windows, filters, beam homogenizers and other components in the beam path, and simple aging of the spectrometer electronic circuits. Examples of

the later include the temperature of the sample and reference gases within their analyzing chambers, their humidity and pressure, and the effect of environmental conditions such as temperature, pressure and humidity level on any of the previously mentioned groups of component parts of the system.

In a number of locations in US 5,747,809, e.g. col. 3, lines 29-30, col. 6, lines 15-18, col. 9, lines 39-41 and lines 57-58, Eckstrom emphasizes the necessity of ensuring that the reference chambers are free of the analyte, and this would appear to be an essential feature of his invention. Indeed, "a reference cell free of the analyte molecule" appears as an element of every one of the claims of Eckstrom. Such a reference cell which is free of the analyte being measured, since it does not absorb the reference beam in the same spectrally characteristic manner as the analyte gas in the sample chamber, is not sensitive to spectrally dependent changes in measurement conditions, such as could arise from environmental or opto-mechanical changes in the sample gas itself, in the source(s), detector(s), filter(s), windows or any other spectrally sensitive component disposed in the beam path. For this reason, an instrument with an analyte free reference chamber, such as that of Eckstrom would, to the best of the applicants' understanding, not be able to accurately follow and compensate for such changes in environmental or opto-mechanical conditions present in using the instrument. The analyte-free reference chamber of Eckstrom would appear, to the best of the present applicants' understanding, to essentially perform normalization of the **overall intensity** of the source, without relating at all to its spectral content. In this respect, it appears to the applicants that the **reference** chamber(s) of Eckstrom play the part of the **zero calibration channel** of the present application, as disclosed, *inter alia*, in Figs. 1A, 1B, 4, 5, 11 and 13 of the present application, and whose function is to normalize the isotopic ratio measurements to overall changes in integrated source intensity. However, as stated above, it is not only overall integrated intensity which is important in such ratio measurements, but also the relative spectral component intensities of the light transmitted through the chambers.

In contrast to the analyte-free reference chambers of Eckstrom, the isotopic gas-filled reference chamber(s) of the present invention are used for comparison of the reference chamber absorption with that of the sample chamber, over the entire spectral range of the absorption lines, and thus take into account operating condition changes or environmental changes which affect the spectral structure of the absorption spectrum.

The importance of the use of reference chambers containing a gas fill of the isotopes to be measured is to be found in the specification of the present application on page 5, third paragraph, where it states that:

> " ..... the NDIR spectrometer is constructed and operative with the reference and sample channels in close thermal and physical contact, and with gas fills of closely matched partial pressures of the isotopes of interest, such that both are affected in a similar manner by changes in environmental conditions. **The reference gas channel therefore fully follows the physical, electronic and environmental changes which occur in the whole system and accurately tracks changes in absorption due to these factors in the sample gas.**" (Emphasis added.)

As indicated above, the use of a reference chamber **free** of the analyte molecule would appear to be an essential and indispensable feature of the Eckstom invention. In response now to the Examiner's obviousness rejection, the applicants therefore respectfully submit that not only is there nowhere mentioned or suggested in Eckstrom, use of any reference gas other than one free of the analyte, but that the Sauke et al. citation, in which the reference chamber **does** contain the analyte molecule, teaches away from what is described in the Eckstrom reference. The applicants therefore submit that it may not be valid to combine the Sauke et al. and Eckstrom patents to render claims of the present application as obvious.

Furthermore, the applicants respectfully submit that even if this were not the case, which the applicants do not accede to, the use of a reference chamber containing the isotopes to be measured, cannot be considered "merely substitution of one known reference gas for another", as asserted by the

Examiner, since the isotope-containing reference chamber fulfils a significantly different function in the present system from that of a reference chamber not containing the isotope to be measured, as expounded hereinabove.

Claim162 stands rejected under 35 U.S.C 103(a) as being unpatentable over Eckstrom in view of Sauke et al. as applied to claims 112-124, 128, 129, 130-134, 136-149, 151, 158-161, 166-176 and 180-190 above, and further in view of Kiefer. The Examiner states that "Kiefer teaches only using the alveolar part of the air to ensure an accurate reading. Hence it wold have been obvious to modify the above combination to only use alveolar air to ensure an accurate reading."

The applicants respectfully submit that the Examiner's 35 U.S.C 103(a) rejection of the base claim 112 is incorrect, as expounded in detail hereinabove, and that claim 112 is deemed allowable. Claim 162, being ultimately dependent on claim 112, and reciting further patentable matter, is thus also deemed allowable.

Conclusion

The applicants therefore respectfully submit that, for the reasons mentioned above, claims 112-126, 128, 129, 130-134, 136-149, 151, 158-162, 166-176 and 180-190 are novel, are unobvious over the prior art combination cited by the Examiner, and recite patentable material. Claims 112-126, 128, 129, 130-134, 136-149, 151, 158-162, 166-176 and 180-190 are therefore deemed to be allowable. Reconsideration and prompt allowance of this application are therefore respectfully requested. The applicants also respectfully request postponement of amendment of claims 127, 135, 150, 151, 163-165, 177 and 178 to independent form including all of the limitations of the base claim and any intervening claims, pending the Examiner's reconsideration of this application.

Respectfully submitted